A V_{s30} Map for New Zealand based on surficial geology, topography and direct measurements

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1. Background and Objectives

When designing structures to withstand future earthquakes, the potential damage resulting from a range of hypothetical future earthquake scenarios must be estimated. The influence of local geology on observed ground motions has an outsized role in affecting observed ground motions; it is commonly quantified simplistically with the parameter V_{s30} (time-averaged 30m depth vertical shear wave velocity). We are developing a continuous V_{s30} map for New Zealand, using multiple datasets. The map will be useful in routine engineering analyses, in building code updates, and in research on site response and ground motion simulation.

2. Previous Work and Methodology

Previous researchers have developed regional V_{s30} maps based on correlations with geology (e.g. Wills & Clahan 2006, Perrin et al. 2015) and/or topography (e.g. Allen & Wald 2009). These approaches have shortcomings however in that they are unable to incorporate field V_{s30} measurements in a geographically consistent manner.

To address this, Thompson et al. (2014) provided a method for regional V_{s30} mapping that includes geologic and topographic correlations, combined with a geostatistical approach (regression Kriging) for parsimoniously handling point V_{s30} measurements. The advantages of this approach are:

- honouring V_{s30} measurements at measurement locations;
- applying reasonable inferences based on geologic and topographic data for areas where direct V_{s30} measurements are unavailable;
- quantifying the uncertainty across regions with both rich and sparse field data density;
- establishing a framework for routine map updates when additional field data is collected.

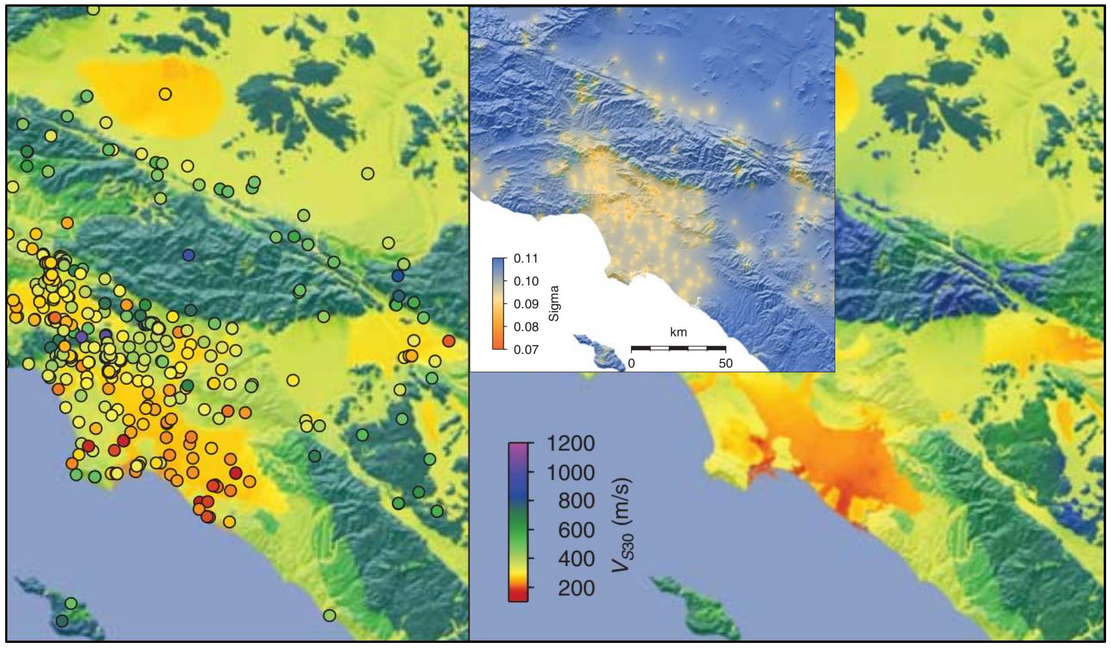

Figure 1: Methodology by Thompson et al. Applied in Los Angeles, California. *Left*: V_{s30} map based on geology and topography with V_{s30} datapoints shown. *Right*: Final map with Kriging applied. *Inset*: Kriging uncertainty increases with distance from point observations.

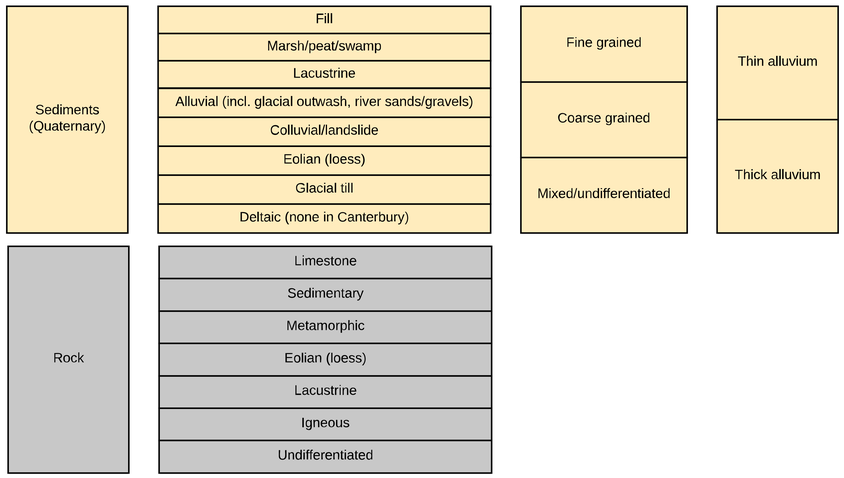

Figure 2: Geologic grouping categories. Both rock and soil are classified according to broad depositional or formational mechanism; soil units are additionally classified according to grain size and thickness of deposit. (Grouping by soil deposit thickness is intended to partially correct for the so-called "thin alluvium problem," which arises when surface geology suggests low V_s but actual V_{s30} values are high because of shallow underlying rock units).

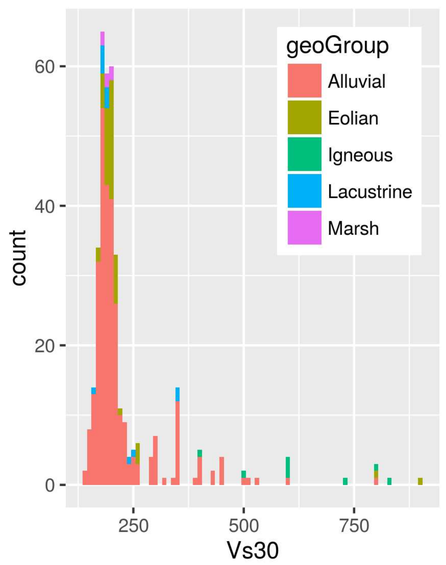

Figure 3: Distribution of Vs30 data in Canterbury region. The data is dominated by Christchurch alluvial deposits.

3. Summary of Work to Date

In this poster, preliminary findings are presented for the current research. We are applying the method of Thompson et al. to New Zealand. The computational framework is under development for the Canterbury region, where Vs30 data is dense following numerous field investigations in the aftermath of major earthquakes. Extension of the method to the rest of New Zealand is relatively straightforward, with the major consideration being the relatively sparse V_{s30} data in most parts of New Zealand. The driving factor in model mean and uncertainty is therefore the asymptotic semivariogram value applied in the Kriged component of the model.

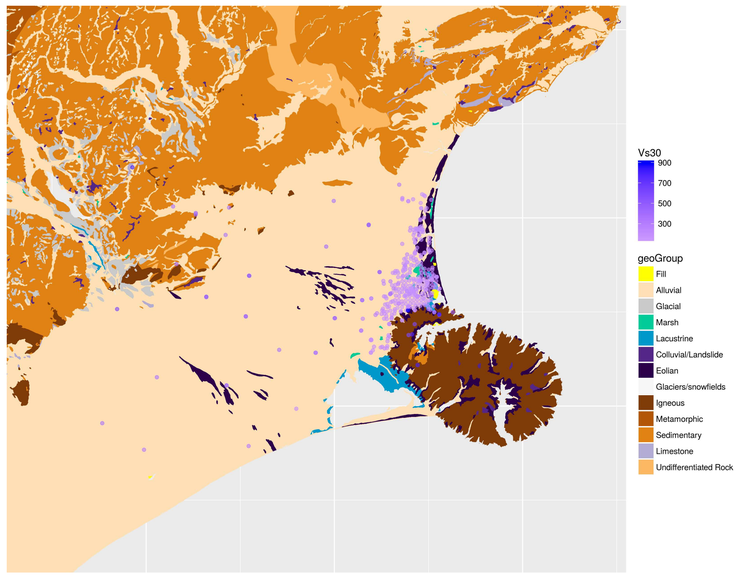

Figure 4: Geologic units for Canterbury region with field V_{s30} data overlay

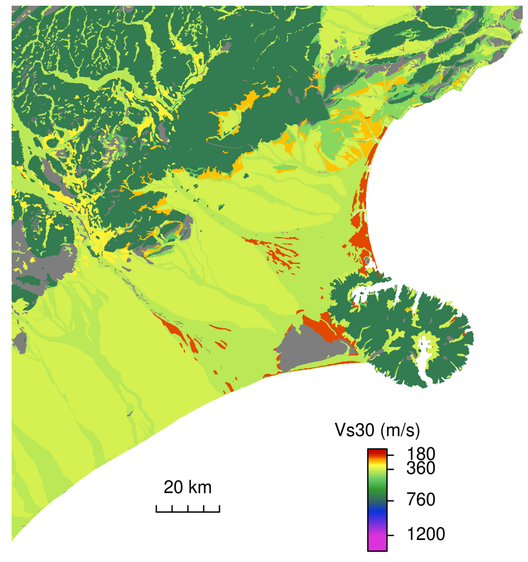

Figure 5: Current geology-only map for Canterbury region with assumptions for low-data units